SMART DESIGN FOR DIGITAL MANUFACTURING IN A CONNECTED MARINE INDUSTRY VALUE CHAIN

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Introduction

Digitalisation of ship design, construction and operation are gaining increasing attention in the marine industry as ships become more eco-friendly and fuel-efficient. With the advent of industry 4.0, manufacturing is now moving towards more intelligent systems that are highly connected. Ships are also becoming smarter with more automation and progressively moving towards fully autonomous vessels. Despite these advances, progress in the area of smart design relative to developments in smart manufacturing and smart vessels, are somewhat limited. The lifecycle and key stages of ship are illustrated in figure 1.

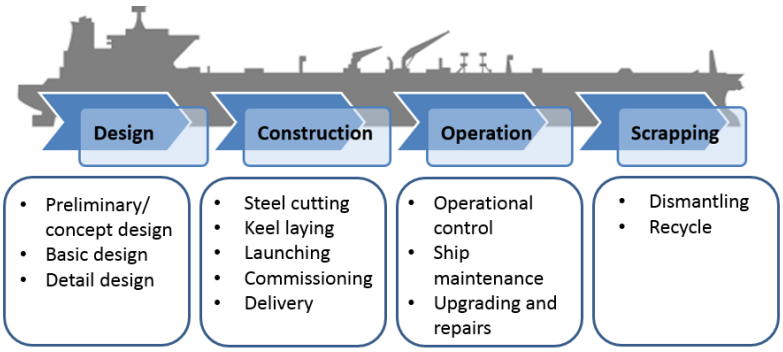

Figure 1: Ship life-cycle and key stages

Methodology

By connecting smart design, smart manufacturing and smart operations into a unified digital model, important information can be shared seamlessly across the entire product lifecycle of a ship in a fully connected through-life smart shipping network as introduced in figure 2.

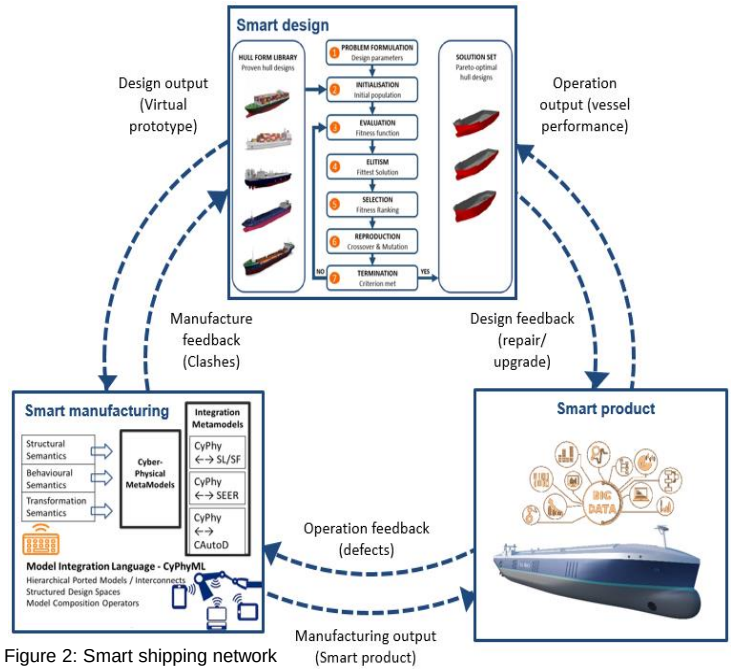

Figure 2: Smart shipping network

Under this through-life smart shipping framework as proposed in [1], smart design can be interconnected with smart manufacturing and smart operations for product through-life consideration. Useful through-life data such as the vessel's operating environment and actual performances can be collected, analysed and feedback into smart design process to improve the design performance of future vessels.

Smart design

An example of smart design is the Hybrid Evolutionary Algorithm and Morphing Approach (HEAM), as introduced by [2] for hull form design and optimisation. Here, we utilise existing hull form data to automatically search and produce optimal design with minimal user intervention. This is achieved by combining the advantages of evolutionary algorithm - ability to search for best global solution, and that of morphing - ability to generate smooth intermittent shapes from the combination of two or more hull form designs.

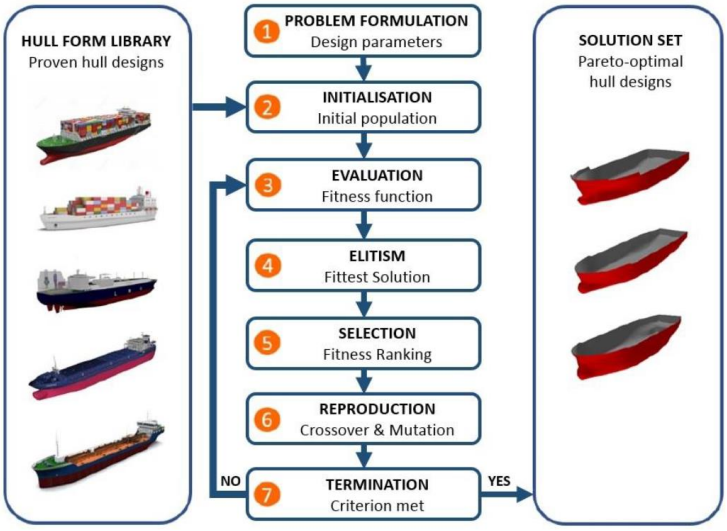

Figure 3: HEAM framework

Benefits

- A more automated and efficient process through connection and collaboration between process network.
- Connected and collaborative process allows exchange of information and real-time adjustments based on design/ manufacture/ operation requirements.

Conclusion

Through the application of computational intelligence to hull form design, a hybrid framework integrating smart design and smart manufacturing for the development of smart product is proposed. It is envisaged that this is a step forward in achieving the vision of fully connected cyber-physical chain in an industry 4.0 environment.

Acknowledgments

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References

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[2] Ang, J.H., Goh, C., Jirafe, V.P. & Li, Y. 2017. Efficient hull form design optimisation using hybrid evolutionary algorithm and morphing approach; Conference on Computer Applications and Information Technology in the Maritime Industries, 3-4 October 2017, Singapore.